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AUTHOR Bamford, Kathryn W.; Mizokawa, Donald T.
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ABSTRACT

The enhanced metalinguistic abilities demonstrated by additive-bilingual children, including superior control of cognitive processing, may promote the development of symbolic reasoning. Children educated in additive-bilingual (immersion) settings may maintain normal native-language development, while acquiring a second language. This study compared 15 children in a Spanish immersion class with 15 children from a standard classroom over the course of three observations during second and third grades. Program type (immersion verses standard) was the independent variable in two comparisons, with nonverbal problem-solving as measured by the appropriate form of Raven's Matrices as the first dependant variable and native-language development as labeled by the Peabody Picture Vocabulary Test-R (PPVT-R) as the second dependent variable. For nonverbal problem-solving, an independent samples t-test on the mean gain in rank revealed significant differences in favor of the immersion children at the third observation, supporting the previously reported results of the second observation. A MANOVA applied to the PPVT-R scores over the three observations revealed no significant differences. The outcomes support the role of bilingualism in the development of symbolic reasoning among children in the early stages of bilingualism, and Lambert's notion of "additive-bilingualism." (Author/JL)

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Cognitive Development of Children in an Additive-Bilingual Program: The Third Report

Kathryn W. Bamford and Donald T. Mizokawa

University of Washington
College of Education

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Abstract

The enhanced metalinguistic abilities demonstrated by additive-bilingual children, including superior control of cognitive processing, may promote the development of symbolic reasoning. Children educated in an additive-bilingual (immersion) setting may maintain normal native-language development, while acquiring a second language. This study compared 15 children (6 boys and 9 girls) in a Spanish-immersion class with 15 children (9 boys and 6 girls) from a standard classroom over the course of three observations during second and third grades. Program was the independent variable in two comparisons, with nonverbal problem-solving as measured by the appropriate form of Raven's *Matrices* as the first dependent variable, and native-language development as measured by the *Peabody Picture Vocabulary Test-R* (PPVT-R) as the second. In terms of nonverbal problem-solving, an independent samples *t*-test on the mean gain in rank revealed significant differences in favor of the immersion children at the third observation, $t = 2.42$, $df = 28$, $p = .02$, supporting the previously reported results of the second observation. A MANOVA applied to the PPVT-R scores over the three observations revealed no significant differences using the Hotelling's T^2 criterion. Outcomes were interpreted to support the role of bilingualism in the development of symbolic reasoning among children in the early stages of bilingualism, and Lambert's (1984) notion of "additive-bilingualism."

The Cognitive Development of Children in an Additive-Bilingual Program: The Third Report

A traditional question in Western education asks whether certain educational experiences, such as second language acquisition, may enhance a child's cognitive development. Although the notion fell into disfavor early in the twentieth century (Hakuta & Diaz, 1986), since 1962 research in bilingual development has produced an impressive body of literature suggesting that children in additive-bilingual settings may experience certain cognitive gains over their monolingual peers (for a review, see Cummins, 1976) while maintaining their native-language ability (Bamford & Mizokawa, 1989). Recently, studies conducted among primary grade children in additive-bilingual settings have indicated that children in the early stages of bilingualism may demonstrate significant gains in nonverbal problem-solving over their monolingual peers (Samuels & Griffore, 1979; Bamford & Mizokawa, 1989), and that among such children, a significant relationship exists between degree of bilingualism and nonverbal problem-solving ability (Hakuta, 1987; Bamford & Mizokawa, 1989). The necessarily quasi-experimental nature of all bilingual research calls for further investigation. Specifically, longitudinal study is necessary to determine the developmental path of the demonstrated gains in nonverbal problem-solving ability by bilingual children. Finally, the social significance of the question at a time when bilingual education programs in North America are

expanding to serve the needs of both majority- and minority-language children requires continued research.

Nonverbal Problem-Solving

Vygotsky asserted that metalinguistic reflection plays an important role in a child's ability to control cognitive processing (Vygotsky,1986; Wertsch, 1985; Donaldson, 1978) . In Vygotsky's (1986) view, metalinguistic ability is one form of conscious realization that is inherent in abstract, decontextualized thought and that leads to voluntary control of consciousness. Research since 1972 has confirmed that bilingual children possess a special objective awareness of language or metalinguistic ability, when compared to their monolingual peers (Ben-Zeev 1977a, 1977b; Bialystok, 1986a; Cummins, 1978; Ianco-Worrall, 1972).

Recently, Bialystok (1985, 1986b, 1988) examined the current array of metalinguistic tasks and identified two underlying abilities necessary for their successful performance: analysis of linguistic knowledge and control of processing. In addition, the author demonstrated that bilingual children are superior to monolinguals in the performance of metalinguistc tasks requiring high levels of control of processing. Bialystok (1986b) compared 102 children from French-immersion and standard monolingual classrooms in grades 1 and 3 on grammaticality judgment and correction tasks. The immersion children showed significantly greater ability to "resist altering meaning while performing grammatical repairs" (p. 508), a measure of cognitive

control. In a later study, Bialystok (1988) compared grade 1 children who were monolingual English-speaking (n = 20), partially French-English bilingual (n = 20) or fully bilingual French-English (n = 17). The children participated in "arbitrariness of language" tasks which require control of processing skills, and "concept of word" tasks that demand analyzed knowledge. In outcomes relevant to this discussion, both bilingual groups scored significantly higher than the monolingual group on the tasks demanding control of processing ability.

The development of nonverbal problem-solving abilities may be enhanced by the superior metalinguistic ability and control skills of children in the early stages of bilingualism. Samuels and Griffore (1979) investigated the influence of French-immersion education on the development of 10 girls and 8 boys in a K-1 class in New York state, in comparison with that of 8 girls and 5 boys in an English monolingual K-1 classroom of similar socio-economic background. The groups were compared on the verbal and performance subtests of the *Wechsler Intelligence Scale for Children* in a pretest-posttest design. At the end of the school year, results of a repeated measures analysis of variance indicated significant differences in favor of the French-immersion in overall performance subtest scores.

In the first report of the the current investigation, Bamford and Mizokawa (1989) compared a Spanish-immersion classroom (8 boys and 11 girls) with a standard monolingual classroom (11 boys and 8 girls) on Raven's *Coloured Matrices*, as a measure of nonverbal

problem-solving ability. Both classrooms were of similar educational and socio-economic status. A repeated measures analysis of variance revealed a significant interaction in favor of the Spanish-immersion classroom over the course of the second-grade year.

As MacNab (1979) noted, the necessarily quasi-experimental nature of intact-group designs in immersion research, such as Samuels and Griffore (1979) and Bamford and Mizokawa (1989), does not allow alternative hypotheses for the results to be ruled out. Within-group analyses, in contrast, avoid difficulties of group equivalence by looking at performance within a population of bilingual children, although the design continues to lack random selection of subjects. Hakuta (1988) and Hakuta and Diaz (1985) examined the relationship between bilingualism and nonverbal cognitive ability as measured by Raven's *Coloured Matrices* among children participating in a primary-grade Spanish-English bilingual program. Although the educational setting over the course of the elementary school grades would be in Lambert's (1984) terminology "subtractive," during the primary grades the children were taught in Spanish half the school day in a program that included Spanish literacy skills. Hakuta (1988) pointed out that such support for native-language development would allow the primary years of the program to be considered an "additive-bilingual setting." Results of a stepwise multiple regression analysis indicated that in grades K and 1, the degree of bilingualism significantly predicted nonverbal problem-solving ability among the 38 children who

participated in the first cohort. However, results were weaker among older cohorts.

In the second report of the present investigation, Bamford and Mizokawa (1989) looked at the relationship between degree of bilingualism and nonverbal problem-solving among 40 members of a second grade Spanish-immersion program. Degree of bilingualism was measured by a score on the Spanish version of the *Peabody Picture Vocabulary Test*, and nonverbal problem-solving by a score on the Raven's *Coloured Progressive Matrices*. A simple regression analysis indicated that degree of bilingualism significantly predicted nonverbal problem-solving ability.

Native-Language Development

The notion that all language development, including native-language and subsequently acquired languages, is founded upon an underlying linguistic competence has been asserted by Chomsky (1972) and Cummins and Swain (1986). The developmental-interdependence hypothesis posited by Skutnabb-Kangas and Toukomaa (cited by Cummins, 1978; Cummins and Swain, 1986) is consistent with such a conceptualization. The hypothesis states that, given adequate exposure and motivation to learn two languages, instruction in either language will transfer to and support development in the other. Lambert (1984) has termed "additive-bilingual" a setting where support for native language development from the home and community motivates children to maintain their native-language development while being

instructed intensively in a second language. In contrast, in a "subtractive-bilingual" environment, children do not receive such support, and the outcome may often be low levels of achievement in both native and second languages (Lambert, 1984).

Immersion education is an additive-bilingual context. Thus current theory would predict that children participating in immersion education would experience no detriment to their native-language development while being educated almost entirely in a second language. Indeed, results of evaluations of French-immersion programs in Canada have indicated that children maintain their native-language development in comparison to their monolingual peers (Barik & Swain, 1976; Bruck, Lambert & Tucker, 1974; Gray, 1986, Lambert, Tucker & d'Anglejan, 1973; Swain, Lapkin & Andrew, 1981). In programs where the immersion children showed an initial lag in English language development, no significant differences were reported after the introduction of English language-arts instruction (Barik & Swain, 1975; Genesee, Holobow, Lambert, Cleghorn & Walling, 1985; Shapson & Day, 1982). In the earlier cited New York state study by Samuels and Griffore (1979) of a K-1 French-immersion program, a repeated measures analysis of variance revealed no significant differences between the immersion children and their comparison group on the verbal subtest of the *Wechsler Intelligence Scales for Children*. Finally, in the second report of this research series, Bamford and Mizokawa (1989) compared the native-language

development of 19 Spanish immersion second-grade children with 18 members of a monolingual comparison classroom as measured by the PPVT. An independent samples *t*-test comparing the mean gain scores of the two groups over the course of the school year revealed no significant differences between the classes.

Harley, Hart and Lapkin (1985) have posited that children educated in an additive-bilingual (immersion) setting will not only maintain native-language abilities, but will experience gains in certain native-language skills. In a reanalysis of data collected over a six-year period, the authors matched 22 French-immersion and 22 monolingual-program children on the basis of participation in testing from grade 1 through grade 6. In addition, the two groups of children were matched individually on measures of IQ, gender, age, grade level, and school placement. After grade three, all significant differences on certain subtests of the *Canadian Test of Basic Skills* (CTBS) favored the immersion students, including reading at grade 3, punctuation at grade 6, and reference subtest at grades 3, 5, and 6. The authors termed these results tentative because of small sample size, but argued that the advantages shown by the immersion children were an outcome of metalinguistic insights gained by the additive-bilingual experience.

The Current Study

This investigation is the third report of a longitudinal study of the cognitive development of primary-grade children enrolled in a Spanish-immersion program that is geographically isolated from a

Spanish speaking community (for earlier reports see Bamford, 1988; Bamford & Mizokawa, 1989). Members of the third-grade Spanish-immersion program pilot group in a suburban school district in the state of Washington were compared longitudinally to a standard-program third-grade classroom in the same community on measures of nonverbal problem-solving and native-language development. Additionally, members of the second-grade Spanish-immersion follow-up group were brought into the study for the first time, and compared to a standard-program second-grade comparison group. It was hypothesized that the members of each Spanish-immersion classroom would demonstrate significant gains in nonverbal problem-solving abilities over their respective standard-program comparison group. Second, it was predicted that there would be no significant differences between the immersion and comparison classrooms on a measure of native-language development. Third, it was expected that among the immersion children, native-language development would significantly predict the degree of bilingualism attained. Finally, it was hypothesized that the degree of bilingualism would significantly predict nonverbal problem-solving ability.

Method

Subjects

Subjects selected for this study were the remaining 15 third-graders (6 boys and 9 girls) who were members of an intact immersion pilot classroom when the study began in the fall of 1987, and the

remaining 15 third-graders (9 boys and 6 girls) who in 1987 were members of a standard-program classroom. Over the course of the study, 4 children from both the immersion and comparison classrooms moved out of district. In the spring of 1988, a second Spanish-immersion pilot class was brought into the study to facilitate the within-group comparisons of the Spanish-immersion children, of which 20 (8 boys and 12 girls) remained in 1989. The mean age of the third graders participating in the study was 9 years, 3 months.

The present research also included 39 members of the Spanish-immersion second-grade follow-up group (18 boys and 21 girls) and 20 members (13 boys and 7 girls) of a standard second-grade classroom. The mean age of the second graders participating in the study was 8 years 3 months.

The immersion and comparison classrooms for both the pilot and follow-up groups were located in schools of comparable socio-economic and educational status located in the same suburban community. The comparison classrooms were located in a school which housed a magnet-gifted program. Although only children residing in the attendance zone of the school were included in the analysis, it was felt that the presence of the gifted program created a natural self-selection in the community. The self-selected nature of the comparison classrooms seems appropriate, since the participation in the Spanish-immersion program is voluntary and thus the immersion program classrooms are also self-selected.

T-tests indicated no significant gender or age differences between the respective immersion and comparison classrooms. All children who desired to participate in the study were tested. However, children with a hearing deficit (n = 2) or who had repeated a grade (n = 4) were excluded from the analysis. Among the children in the comparison classrooms, children who lived outside the school zone but were bussed in to attend a program for gifted children (n = 1) and bilingual members (n = 4) were not included in the analysis. No consent forms were available for 3 children in the pilot group, and 3 in the comparison group. Thus these children were not tested.

Instrumentation

The *Standard Progressive Matrices* (SPM) (Raven, 1960) provided a measure of nonverbal problem-solving ability for the members of the pilot (third-grade) group. The *Coloured Progressive Matrices* (CPM) (Raven, 1977) was administered to the follow-up (second-grade) group. The Raven's SPM and CPM have been broadly used in research in additive-bilingualism (see Ben Zeev, 1977b; Diaz, 1985; Hakuta, 1984, 1985, 1987; Hakuta & Diaz, 1985; Hakuta, Ferdman & Diaz, 1986; Lambert & Tucker, 1972; Lambert, Tucker & d'Anglejan, 1973). Kirby and Das (1978) pointed out that the tests have been regarded as "a prototype of a culture-fair measure of intelligence" (p. 94), although recently research has indicated that acquired skills may figure prominently in performance. Significant to this research, the Raven's task involves in Ben-Zeev's (1977b) words "what Piaget calls

'multiplicative classification,' in which the two dimensions of a system must be attended simultaneously" (p. 1014). Thus, a child's ability to control cognitive processing is called into play in performance of the Raven's CPM and SPM. Raven (1977) reported that the test-retest reliability for the CPM ranged from .86 to .90, and internal consistency reliability ranges from .64-.83. For the Raven's SPM test-retest reliability ranged from .55 to .93 , and internal consistency from .60 to .96. Norms for American children on the CPM and SPM have not been accepted by the publisher; thus, raw scores were used in all analyses.

The *Peabody Picture Vocabulary Test-R*(PPVT-R) (Dunn, Dunn, Robertson & Eisenburg, 1981) was selected as a measure of native-language development for both the pilot and follow-up groups. An individually administered test of receptive English vocabulary, the PPVT has been widely used as a measure of English language development in among additive-bilingual children (see Bruck, Lambert & Tucker, 1974; Hakuta, 1987; Hakuta & Diaz, 1985; Lambert & Tucker, 1972; Lambert, Tucker & d' Anglejan, 1973).

The *Test de Vocabulario en Imágenes Peabody* (TVIP) (Dunn, Padilla, Lugo & Dunn, 1986), a test of receptive Spanish vocabulary, was administered to pilot and follow-up members of the immersion program at least one week subsequent to the administration of the PPVT-R. The TVIP is the Spanish adaptation of the PPVT forms *L* and *M*, in which vocabulary items were reordered for more appropriate use in Mexico and Puerto Rico. The internal consistency measure of

reliability was .94 for children from 7 to 9 years of age. No norms are currently available for North American children in Spanish-immersion programs, thus raw scores were used in all analyses of the TVIP.

All instruments were administered individually in a private room at school during the school day by the first author. The *Cross-Cultural Attitude Inventory* (Jackson & Klinger, 1971) was also administered, but has not been analyzed to date. For both the pilot and follow-up groups, program was the independent variable in two comparisons. In the first, nonverbal problem-solving ability was the dependent variable as measured by the CPM or SPM, as appropriate. In the second, native-language development as measured by the PPVT-R was the dependent variable.

Among both pilot and follow-up groups of immersion children, two further comparisons were made. In the first, native-language ability as measured by the PPVT-R was the predictor variable, with bilingual development as measured by the TVIP as the outcome variable. Second, bilingual development as measured by the TVIP was the predictor variable, with nonverbal problem-solving ability as measured by the CPM or SPM as appropriate as the outcome variable. In all cases, alpha = .05.

Results

Nonverbal Problem-Solving

Pilot group. The nonverbal scores of the pilot-group in 1989 were compared longitudinally with those from the first observation in 1987. The pilot children in fall 1987 were second-graders, and were administered the CPM. In the spring of 1989 these children were third-graders, and the SPM was judged more appropriate for their age and abilities. Because of the change in instruments, the differences in rank between the first and third observations were calculated, and a *t*-test applied to the gain scores. The Spanish-immersion group scored significantly higher (M = .269) than the comparison group (M = -.632), $t = 2.42$, $df = 28$, $p = .02$. However, there were no significant differences revealed by the same test applied to the second and third observations. Among the pilot immersion children, a regression analysis was applied to the scores of the SPM and the TVIP with the TVIP as the predictor variable, and the SPM as the outcome variable. The results of the test were not significant.

Follow-up group. A MANOVA was performed on the scores of the follow-up children on the CPM with results of the PPVT-R, gender and age as covariates. The results were not significant. However, among the immersion follow-up group, a regression analysis performed on the scores of the CPM and TVIP with the TVIP as

predictor variable and the CPM as outcome measure was significant, multiple $R = .44$, $p = .006$.

Native-Language Development

Pilot Group. A MANOVA was applied to the immersion and comparison pilot-group scores on the PPVT-R in 1987, 1988, and 1989. The outcome was not significant using the Hotelling's T^2 criterion. However, among the pilot immersion children, the PPVT-R scores significantly predicted those of the TVIP, multiple $R = .347$, $p = .04$.

Follow-Up Group. A MANOVA was applied to the results of the second-grade follow-up group on the PPVT-R, with the CPM, age, and gender as covariates. The results were not significant. In the final comparison, among the follow-up immersion children, higher native-language development again significantly predicted higher degree of bilingualism, using the PPVT-R and TVIP respectively, multiple $R = .35$, $p = .03$.

Discussion

Nonverbal problem-solving. The finding of significant differences in favor of the pilot-immersion group on the measure of nonverbal problem-solving between the 1987 and 1989 observations reveals that the immersion children are sustaining the significant gains reported between 1987 and 1988 (see Bamford & Mizokawa, 1989). However, since no significant differences were reported in gain in rank between 1988 and 1989, it appears that the more important changes in nonverbal problem-solving ability occurred during the second-grade

year. This finding supports Diaz' (1985) observation that "the positive effects of bilingualism are probably related to the initial efforts required to understand and produce a second language." (p. 1387). Further, during the second-grade year, the Spanish-immersion children began their first English language-arts instruction. It may be that the onset of biliteracy, the early stages of bilingual communicative competence, and the rapid development of decontextualized thinking resulting from school entrance interact to give immersion children an extra advantage in cognitive control over their monolingual peers, resulting in the demonstrated gains in nonverbal problem-solving scores. Likewise, while degree of bilingualism was reported to predict nonverbal problem-solving scores at second grade (Bamford & Mizokawa, 1989), the results of the comparison were no longer significant at third grade. This attenuation supports results of studies by Hakuta (1987) and Diaz (1985), and again points to the early stages of bilingualism as the more interesting in bilingual development.

The outcomes for the second-grade follow-up group support those found for the pilot group in 1988 (second grade). While no significant differences in nonverbal problem-solving scores were demonstrated, none were expected, as this observation serves as a baseline measure for further longitudinal observations. More interesting theoretically is the finding that degree of bilingualism again significantly predicted nonverbal problem-solving scores among second graders. This outcome replicates the finding among the pilot

group in second grade (Bamford & Mizokawa, 1989), and again focuses attention on the early stages of bilingualism, biliteracy, and school entry as important in the study of the relationship between language and thought.

Native language development. In terms of native language development, the finding of no significant differences among both the pilot and follow-up groups lends further support to what has become a substantial list of studies indicating that children in additive-bilingual settings suffer no loss of English language development, at least as indicated by the PPVT-R. Further research is called for to explore other facets of native-language development among children in additive-bilingual environments to determine that the outcome is valid. Finally, the finding among both immersion and follow-up children that native-language development significantly predicts second-language development replicates findings among the immersion children reported last year (Bamford & Mizokawa, 1989) and supports principles advocated by Chomsky (1972), Cummins and Swain (1986) and Hakuta (1987). Research extending this question should turn to more linguistically diversified languages, such as among children in Hawaiian-immersion programs (Bowman, 1989).

The results of this study must be interpreted with caution, however, as should the outcomes of any quasi-experimental investigations. McNab (1979) pointed out the role of self-selection in immersion programs and the subsequent difficulties that arise in the

interpretation of immersion research. In this study the immersion children were voluntary participants in their educational program, and they were participating in the pilot and first follow-up group of Spanish-immersion students in their state. It is not unlikely that they are unique, and consequently a rival explanation of the data presented here is that because of their special background the course of their cognitive development would differ from that of any comparison group. Care was taken in the selection of the comparison classrooms in this study in an attempt to offset any such differences in background. Nevertheless, the existence of an alternative explanation should not be overlooked.

Bilingual children are a profoundly heterogeneous population, and generalizations across such a group are ill-advised. Children in an immersion program such as the one described here are subject to a unique mix of social-psychological forces, and applications to other groups of children should be limited only to those subject to the same influences.

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